International Journal of Electronics,
Communication & Instrumentation Engineering
Research and Development (IJECIERD)
ISSN(P): 2249-684X; ISSN(E): 2249-7951
Vol. 4, Issue 3, Jun 2014, 23-26

DATA ACQUISITION AND IMAGE RECONSTRUCTION IN EXPERIMENTAL COMPUTED TOMOGRAPHY

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ABSTRACT

This paper is on data acquisition and image reconstructing in Experimental Computed Tomography. Experimental computed topographic scanner can be used in institute laboratory, colleges for learning which is efficient to understand the actual Computed Tomography working. This paper covers data acquisition and image reconstruction for Experimental computed tomography. The data given to computer is used to reconstruct an image with the help of different reconstruction techniques.

KEYWORDS*:* ECT, Data Acquisition, Image Reconstruction

ABBREVIATIONS*:* CT-Computed Tomography; Experimental Computed Tomography-ECT; Arithmetic Reconstruction technique [ART]; Multiplicative Arithmetic Reconstruction Technique [MART]

INTRODUCTION

Computed Tomography (CT) is a powerful technique for producing cross al images of an object. CT consists of important parts which are source, patient, detector, data acquisition system & image reconstruction. Experimental Computed Tomography is model similar to CT. It also generates cross- al, two-dimensional images of the object. In ECT the attenuation at different points in an object is measured to obtain the information which is used to get desired image as an output. Hence for attenuation, light is selected as source instead of x-ray and photo transistor is used as detector to sense the incident light into electric response. In ECT source and detection technologies evolved to support major CT imaging trends such as increasing number of slices, increased speed of acquisition. CT sources evolved to support larger coverage per rotation and detector elements arrays are the main enabler for the emergence of multi-slice ECT scanners.

ECT consist of source & detector array for acquiring attenuation information, gantry assembly for rotation of source and detector, data acquisition for transferring information from detector to computer for image reconstruction. The transmission of light beam is measured through all possible straight-line paths as in a plane of object and attenuation of light beam is estimated at points in the object & transmitted light is then measured by a ring of sensitive detectors around that object. Source selected is light source that is red light laser diode with output wavelength 650nm. The detector used in this assembly is L14G2 NPN photo transistor with peak wavelength of 940 nm. the source & detector are fixed on mechanical assembly of gantry in opposite direction which rotates from 0 to 360°. Then projections are taken at every 10 degree in translation manner. Signals obtained from array of detectors are transmitted using RF transmitter [3]. Data acquisition is done using RF receiver and microcontroller..Data acquired from many different angles is used for image reconstruction to get topographic image using different reconstruction techniques. Hence it is important to realize that collecting many projections of object and light beam play important role in ECT image formation. Object through

which light is emitted is phantom. Phantom is made up of glass which has object impregnated in it.

Signals obtained from the array of detectors are transmitted with the help of RF transmitter which is placed on the gantry. The data are captured by RF receiver. The received signals are demodulated by using demodulator [3]. The demodulated information signals will be given to microcontroller. Also pulse with synchronization pulse with some time delay is given to microcontroller. These signals are transferred serially to computer. and bplter hhanan klldk jjfjfnfmfn nkdmjk fffg

DATA ACQUISITION

Data Acquisition (DAQ) is defined as the process of taking a real-world signal as input, such as a voltage or current or any electrical input, into the computer, for processing, analysis, storage or other data manipulation or conditioning. A DAQ system consists of RF receiver and microcontroller providing input to computer having programmable software. The block diagram of data acquisition system is shown as follows:

SYNC PULSE FROM DETECTOR

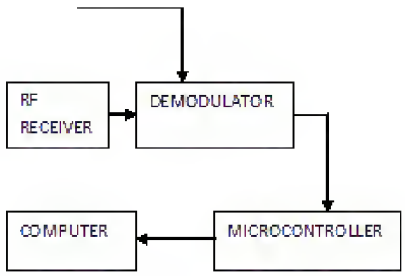

Figure 1: Block Diagram of Data Acquisition System

The data are captured by RF receiver. The received signals are demodulated by using demodulator. The demodulated information signals will be given to microcontroller. Also pulse with synchronization pulse with some time delay is given to microcontroller. Microcontroller used is ATMEL 16. It has 8 channel, 10 bit ADC. It will convert analog data to digital. Every signal is stored as a binary code These signals are transferred serially to computer.

IMAGE RECONSTRUCTION

This data is collected at various angles from 0 to 360 degrees. Any of several algorithms available can then be used to reconstruct its 2D cross- al image from its projections. Fundamentally, tomography deals with reconstruction of an object from its projections. The technique of tomography consists of passing a series of rays (in parallel, fan beam) through an object, and measuring the attenuation in these rays by placing a series of detectors on the receiving side of the object. These measurements are called projections. There are many methods of collecting the projection data. The projections with data which will be acquired will then be used for image reconstruction using various image reconstruction techniques to form reconstructed image. Image reconstruction techniques used are:

- Back Projection.
- Filtered back projection.
- Arithmetic Reconstruction technique.

- Multiplicative arithmetic reconstruction technique

- **Back Projection**

In this method will get started from a projection value and back-project a ray of equal pixel values that would sum to the same value. Back-projected ray will then be added to the estimated image and the process will be repeated for all projection points at all angles. With sufficient projection angles, structures can be somewhat restored.

It is the oldest method not used in commercial CT scanners. Method is analogue to graphic reconstruction. Processing part is simple and direct. Some produced images are 'starred' and 'blurring' that makes it unsuitable for medical diagnosis.

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- **Filtered Back Projection**

Filtered back projection is a technique to correct the blurring encountered in simple back projection. Each of the one-dimensional views is convolved with a one-dimensional filter kernel to create a set of filtered views. These filtered views are then back projected to provide the reconstructed image, a close approximation to the "correct" image. This technique eliminates the unwanted cusp like tails of the projection. The projection data are convoluted with suitable processing function before back projection. The filter function has negative side lobes surrounding a positive core, so that in summing the filtered back projection - positive and negative contribution that cancel outside the central core. Filtered back projection method is excel in speed and accuracy when a large number of projections are available and are extensively used in imaging, direct inversion of the projection formula is available. In this method Homomorphic filter is used It is used in image enhancement & to remove multiplicative noise, it simultaneously normalizes the brightness across an image and increases contrast. The filtered back projection image is as shown as follows:

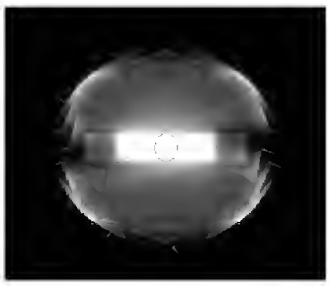

Figure 2: Filtered Back Projected Image

- **Arithmetic Reconstruction Technique**

Each projected density will be thrown back across the reconstruction space in which the densities are iteratively modified to bring each reconstructed projection into agreement with the measured projection. This method will improve

insensitivity to noise and capability to reconstruct an optimum image in case of incomplete data. Slow as compared to filtered back projection.

- **Multiplicative Arithmetic Reconstruction Technique**

It is similar to as ART the only difference is it will use multiplication instead of addition. Also the velocity of convergence is more in ART as compared to MART. In this each projected density will be thrown back across the reconstruction space in which the densities are modified by multiplication operation to bring each reconstructed projection into agreement with the measured projection.

CONCLUSIONS

It is concluded that design of an experiment CT has served as an introduction to computed tomography. Students are now able to perform multiple scans of objects of differing sizes, locations & clear their Concept regarding CT images. Data Acquisition is efficiently done using RF module and micro controller. Thus information is transferred to computer. With the help of various reconstruction algorithms such as back projection, filtered back projection, ART, MART images can be reconstructed with the help of projected data.

ACKNOWLEDGEMENTS

We would like to thank our guide **Prof. Jyothi Warrier** and Co-guide **Prof. Bipin Mokal, Prof. Aarti Bokade and Prof. Nishant Patil**. Also we would like to thank Head of the Department **Dr. G.D. Jindal** for giving us the freedom to select our desired topic for the project work and supporting us in our endeavors.

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